

We claim:

1. An electromagnetic (EM) gage sensing system for measuring at least gage distance between rails of a railroad track comprising:

a first array of EM field generating coils extending substantially across said first rail and beyond an edge surface of said first rail, said first array of EM field generating coils being adapted to generate an EM field;

a first array of EM field sensors positioned substantially between said first rail and said first array of EM field generating coils, said first array of EM field sensors being adapted to sense said EM field generated by said first array of EM field generating coils, and provide a first lateral EM field output signal; and

a processor adapted to process said first lateral EM field output signal to determine position of said edge surface of said first rail.

2. The EM gage sensing system of claim 1, wherein said processor is adapted to determine position of said edge surface of said first rail based on at least one peak of said first lateral EM field output signal.

3. The EM gage sensing system of claim 2, wherein said processor is adapted to determine position of said edge surface of said first rail based on position of an EM field sensor of said first array of EM field sensors that outputs said at least one peak of said first lateral EM field output signal.

4. The EM gage sensing system of claim 3, wherein said processor is further adapted to calculate a first gage based on position of said EM field sensor of said first array of EM field sensors that outputs said at least one peak.

5. The EM gage sensing system of claim 1, wherein said processor is further adapted to average said first lateral EM field output signal over a predetermined length of travel along said first rail.

6. The EM gage sensing system of claim 1, wherein said first array of EM field sensors are further adapted to provide a first vertical EM field output signal indicative of height distance of said first rail.

7. The EM gage sensing system of claim 6, wherein said processor is further adapted to process said first vertical EM field output signal to determine height distance of said first rail.

8. The EM gage sensing system of claim 7, wherein said processor is adapted to determine height distance of said first rail based on magnitude of a valley of said first vertical EM field output signal.

9. The EM gage sensing system of claim 6, wherein said processor is further adapted to average said first vertical EM field output signal over a predetermined length of travel along said first rail.

10. The EM gage sensing system of claim 1, further comprising a second sensor positioned over a second rail of said railroad track, said second sensor extending substantially across said second rail and beyond an edge surface of said second rail, said second sensor including a second array of EM field generating coils adapted to generate an EM field, and a second array of EM field sensors adapted to sense said EM field generated by said second array of EM field generating coils, and to provide a second lateral EM field output signal indicative of position of said edge surface of said second rail.

11. The EM gage sensing system of claim 10, wherein said processor is adapted to determine position of said edge surface of said second rail based on at least one peak of said second lateral EM field output signal.

12. The EM gage sensing system of claim 11, wherein said processor is adapted to determine position of said edge surface of said second rail based on position of an EM field sensor of said second array of EM field sensors that outputs said at least one peak of said second lateral EM field output signal.

13. The EM gage sensing system of claim 12, wherein said processor is further adapted to calculate a second gage based on position of said EM field sensor of said second array of EM field sensors that outputs said at least one peak.

14. The EM gage sensing system of claim 13, wherein said processor is adapted to determine position of said edge surface of said first rail based on position of an EM field sensor of said first array of EM field sensors that outputs said at least one peak of said first lateral EM field output signal, said processor being further adapted to calculate a first gage based on position of said EM field sensor of said first array of EM field sensors that outputs said at least one peak.

15. The EM gage sensing system of claim 14, wherein said processor is further adapted to calculate a total gage by adding said first gage, said second gage and a distance between said first array of EM field sensors and said second array of EM field sensors.

16. The EM gage sensing system of claim 10, wherein said processor is further adapted to average said second lateral EM field output signal over a predetermined length of travel along said second rail.

17. The EM gage sensing system of claim 10, wherein said second array of EM field sensors are further adapted to provide a second vertical EM field output signal indicative of height distance of said second rail.

18. The EM gage sensing system of claim 17, wherein said processor is further adapted to process said second vertical EM field output signal to determine height distance of said second rail.

19. The EM gage sensing system of claim 18, wherein said processor is adapted to determine height distance of said second rail based on magnitude of a valley of said second vertical EM field output signal.

20. The EM gage sensing system of claim 17, wherein said processor is further adapted to average said second vertical EM field output signal over a predetermined length of travel along said second rail.

21. The EM gage sensing system of claim 10, further including a fixture adapted to mount said first array of EM field generating coils and said first array of EM field sensors over said first rail, and said second array of EM field generating coils and said second array of EM field sensors over said second rail.

22. The EM gage sensing system of claim 1, wherein said processor is a neural network based processor.

23. The EM gage sensing system of claim 22, wherein said processor is adapted to be trained.

24. The EM gage sensing system of claim 23, wherein said processor is adapted to be trained using a training data set covering an expected range of rail positions relative to said first array of EM field sensors.

25. The EM gage sensing system of claim 1, further including a fixture adapted to mount said first array of EM field generating coils and said first array of EM field sensors over said first rail.

26. The EM gage sensing system of claim 10, wherein said first array of EM field generating coils and said second array of EM field generating coils generate EM fields between 1 KHz and 9 KHz.

27. The EM gage sensing system of claim 1, wherein said first array of EM field generating coils generates an EM field between 1 KHz and 9 KHz.

28. A method of measuring at least gage distance between rails of a railroad track comprising the steps of:

positioning an array of electromagnetic (EM) field generating coils over a rail of said railroad track to generate EM fields over said rail;

positioning an array of EM field sensors substantially between said EM field generating coils and said rail; and

sensing EM fields and providing at least a lateral EM field output signal indicative of position of an edge surface of said rail.

29. The method of claim 28, wherein said EM field generated is between 1 KHz and 9 KHz.

30. The method of claim 28, wherein said array of EM field generating coils and said array of EM field sensors are positioned to extend substantially across said rail beyond said edge surface.

31. The method of claim 28, further including the step of determining position of an edge surface of said rail based on at least one peak of said lateral EM field output signal.

32. The method of claims 31, wherein said step of determining position of said edge surface includes the step of determining position of an EM field sensor in said array of EM field sensors that outputs said at least one peak.

33. The method of claim 28, further including the step of averaging said lateral EM field output signal over a predetermined length of travel along said rail.

34. The method of claim 28, further including the step of providing a vertical EM field output signal indicative of height distance of said rail.

35. The method of claim 34, further including the step of determining height distance of said rail based on at least one valley of said vertical EM field output signal.

36. The method of claim 35, further including the step of averaging said vertical EM field output signal over a predetermined length of travel along said rail.

37. The method of claim 28, further including the step of processing said lateral EM field output signal to determine position of an edge surface of said rail.

38. The method of claim 37, wherein said step of processing said lateral EM field output signal to determine position of an edge surface of said rail is attained using a processor.

39. The method of claim 38, wherein said processor is a neural network based processor.

40. The method of claim 39, further including the step of training said processor.

41. The method of claim 40, wherein said step of training said processor is attained using a training data set covering an expected range of rail positions relative to said first array of EM field sensors.

42. A method of measuring at least gage distance between rails of a railroad track comprising the steps of:

positioning a first array of electromagnetic (EM) field generating coils over a first rail of said railroad track, said first array of EM field generating coils extending substantially across said first rail beyond an edge surface of said first rail to generate an EM field over said first rail;

positioning a first array of EM field sensors substantially between said first array of EM field generating coils and said first rail, said first array of EM field sensors extending substantially across said first rail beyond said edge surface of said first rail, each EM field sensor of said first array of EM field sensors sensing said EM field generated over said first rail and providing a corresponding output;

determining which EM field sensor of said first array of EM field sensors is providing strongest output; and

determining position of said edge surface of said first rail based on position of said EM field sensor of said first array of EM field sensors providing strongest output.

43. The method of claim 42, further including the step of calculating a first gage based on position of said EM field sensor of said first array of EM field sensors providing strongest output.

44. The method of claim 42, further including the step of averaging said outputs of said EM field sensors of said first array of EM field sensors over a predetermined length of travel along said first rail.

45. The method of claim 42, further including the step of determining a first height distance between said first rail and said first array of EM field sensors based on a vertical component of said outputs of said EM field sensors of said first array of EM field sensors.

46. The method of claim 45, wherein said step of determining said first height distance includes the step of determining a minimum of said outputs of said EM field sensors of said first array of EM field sensors.

47. The method of claim 42, further comprising the steps of:

positioning a second array of electromagnetic (EM) field generating coils over a second rail of said railroad track, said second array of EM field generating coils extending substantially across said second rail beyond an edge surface of said second rail to generate an EM field over said second rail;

positioning a second array of EM field sensors substantially between said second array of EM field generating coils and said second rail, said second array of EM field sensors extending substantially across said second rail beyond said edge surface of said



second rail, each EM field sensor of said second array of EM field sensors sensing EM fields generated over said second rail and providing a corresponding output;

determining which EM field sensor of said second array of EM field sensors is providing strongest output; and

determining position of said edge surface of said second rail based on position of said EM field sensor of said second array of EM field sensors providing strongest output.

48. The method of claim 47, further including the step of calculating a second gage based on position of said EM field sensor of said second array of EM field sensors providing strongest output.

49. The method of claim 48, further including the step of calculating a first gage based on position of said EM field sensor of said first array of EM field sensors providing strongest output.

50. The method of claim 49, further including the step of calculating a total gage between said first rail and said second rail by adding said first gage, said second gage, and a distance between said first array of EM field sensors and said second array of EM field sensors.

51. The method of claim 47, further including the step of averaging said outputs of said EM field sensors of said second array of EM field sensors over a predetermined length of travel along said second rail.

52. The method of claim 47, further including the step of determining a second height distance between said second rail and said second array of EM field sensors based on a vertical component of said outputs of said EM field sensors of said second array of EM field sensors.

53. The method of claim 47, wherein said step of determining said second height distance includes the step of determining a minimum of said outputs of said EM field sensors of said second array of EM field sensors.

54. The method of claim 42, wherein said step of determining position of said edge surface of said first rail based on position of said EM field sensor of said first array of EM field sensors providing strongest output is attained using a processor.

55. The method of claim 54, wherein said processor is a neural network based processor.

56. The method of claim 55, further including the step of training said processor.

57. The method of claim 56, wherein said step of training said processor is attained using a training data set covering an expected range of rail positions relative to said first array of EM field sensors.